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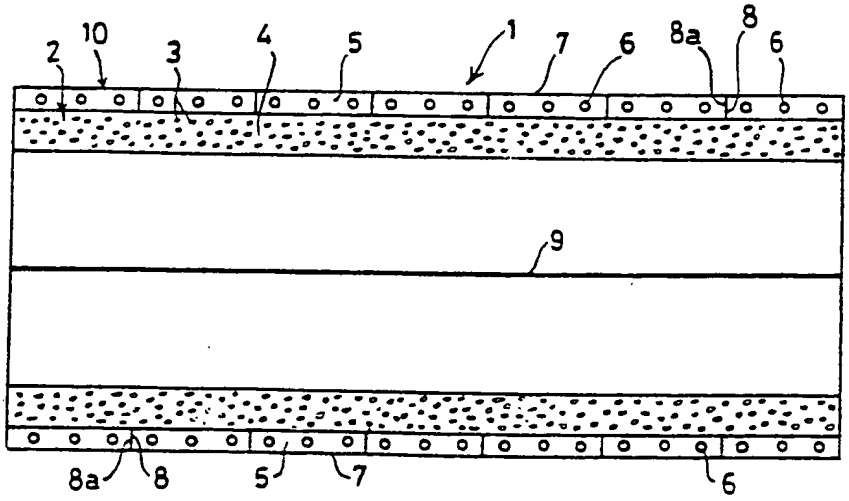
(54) Title: PLASTIC PIPE WITH A WALL MADE UP OF A PLASTIC-FILLER LAYER



(57) Abstract

A plastic pipe (1) having a wall consisting of a thermoplastic-filler layer (2) covered at one or both sides with .. fibre reinforced thermoplastic layer (10). The thermoplastic is polypropylene, preferably a polypropylene copolymer. The filler is a particulate inorganic filler material such as sand and the thermoplastic-filler layer contains at least 60-95 % b.w. of filler. The fibre reinforced layer (10) is formed by tangentially winding a plastic tape of polypropylene or polypropylene copolymer comprising a longitudinally extending reinforcement preferably in the form of a continuous glass fibre. The pipe of thermoplastic-filler layer (2) may advantageously be formed by shaping an extruded or cast sheet of thin web (11) of thermoplastic-filler material and subsequently welding the edge sections of such a sheet or web together by means of weld joint (9). The shaping of the sheet or web is executed at a temperature within the softening range of the thermoplastic. The pipe may also be formed by winding a sheet or web (11) the subsequent layers of sheet or web (11) being preferably joined to each other by melting the thermoplastic. At last the pipe (1) may contain a reinforcing tape (5') comprising a reinforcement extending in the axial direction of the pipe (1).

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Plastic pipe with a wall made up of a plastic-filler layer.

The invention relates to a plastic pipe, having a wall comprising a plastic-filler layer which has a high filler content and which is covered at least on one side by a fibre-reinforced plastic layer.

A plastic pipe of this type, having a wall made up of a core of inorganic filler particles bound by a thermosetting resin, said core being covered on both sides with a fibre-reinforced layer of thermosetting resin, is known.

The drawbacks of a pipe of this type are, inter alia, the high cost price because of the use of thermosetting plastic, the limited impact strength and the impossibility of reusing scrap and waste material, while, moreover, connections by means of welding are not possible.

The aim of the invention is now to provide a plastic pipe of the abovementioned type which does not present these disadvantages.

This aim is achieved according to the invention in that the plastic of the filler layer and of the fibre-reinforced layer consists of a thermoplastic.

By using a thermoplastic as binder for the filler and as material for forming the covering layer, a pipe can be formed which can easily be joined to another pipe by welding together. Moreover, a pipe of this type can easily be produced by, for example, extruding, casting or rolling a sheet from the thermoplastic containing filler particles and bending over this sheet, after partial cooling, and welding the longitudinal edges together to form a pipe-shaped body which is then wound with plastic tape.

Advantageously the plastic of the plastic-filler layer consists of a polyolefin in particular polypropylene.

Polypropylene has the great advantage that,

because of its favourable melting characteristics, this polymer becomes a fluid of very low viscosity and thus can be mixed well with filler, as a result of which the resulting mass can then easily be extruded to a pipe or can be extruded, cast or rolled into sheets.

Preferably, a polypropylene copolymer is used, which has a better impact strength than polypropylene homopolymer, while the filler advantageously consists of sand because of the price and availability. The plastic-filler layer preferably consists to 60-95 percent by weight of filler and advantageously to 75-90 percent by weight of filler. Plastic pipes according to the invention can be joined in ways customary for thermoplastic pipes; in particular, weld connections are possible.

The fibre reinforcement expediently extends in the longitudinal direction of the plastic tape, preferably continuously, which plastic tape is preferably wound substantially tangentially.

As a result, a high resistance is obtained to the internal pressure of media transported through the pipe.

The amount of tangentially wound plastic tape essentially determines the said resistance to internal pressure.

The plastic pipes according to the invention can be used both for line systems under atmospheric pressure and for pressurised line systems.

In the case of lines under atmospheric pressure, winding of the plastic-filler layer with a fibre-reinforced plastic tape offers a better mechanical strength during, for example, transport and laying than a pipe consisting of a plastic-filler layer alone, although the latter could be adequate in respect of the rigidity. In the case of pressure lines for low pressures, for example 6 or 10 bar, the combination of plastic-filler layer and fibre-reinforced layer gives the desired rigidity when under atmospheric pressure, although here the fibre-reinforced layer on its own would be adequate for the resistance to internal pressure.

The characteristics of seven different pipes are

compared with one another in the appended table A.

The reference material here was a conventional PVC pipe with an external diameter of 315 mm and a wall thickness of 7.7 mm which can be used both for pressure lines under 6.3 bar and for sewer lines with an STIS of 4000 N/m^2. It is found that a polypropylene (PP) pipe must be appreciably thicker for a similar pressure category. A PP pipe would also be thicker for a similar rigidity. An FRPP (glass fibre reinforced polypropylene) pipe for 6 bar has a completely inadequate rigidity with an STIS of 49 N/mm^2, while a TPC pipe (sand with polypropylene) cannot withstand internal pressure. The combination of a polypropylene/sand pipe with a glass fibre-reinforced polypropylene covering, on the outside or inside and outside, does give the desired results.

The following material characteristics of the various materials used in the plastic pipe according to the invention were used for calculation of the characteristics of said plastic pipes, PP denoting polypropylene and PVC polyvinyl chloride.

TABLE B

Characteristics of a few materials

	sand	PP	PVC	sand/PP 80/20	PP/ glass tape
Modulus of elasticity (kN/mm^2)	73	1.0	3.0	1.70	25.0
Elongation at break (%)	--	500	50	2.5	4
Tensile strength (N/mm^2)	--	30	50	3	400
Permissible wall stress (N/mm^2)	--	50	12.5	--	100

It is pointed out that plastic compositions consisting of fillers held together by thermoplastics are known per se, which can be used for forming pipes. However, in the case of these pipes no reinforcements are applied to the inside and/or outside by winding with a

fibre-reinforced plastic tape, so that they cannot be used effectively in practice.

The invention will now be illustrated with reference to an illustrative embodiment by means of the drawing, in which:

Fig. 1 - shows a plastic pipe according to the invention in longitudinal section;

Fig. 2 - a longitudinal section of a variant of a plastic pipe according to Fig. 1;

Fig. 3 - a longitudinal section of a second variant of a plastic pipe according to Fig. 1;

Fig. 4 - a longitudinal section of a plastic pipe according to the invention, in which the pipe core is formed by winding, and;

Fig. 5 - a side view of a variant of a pipe according to Fig. 4.

In Fig. 1 a plastic pipe 1 is shown which consists of a pipe-shaped core 2 formed by sand particles 3 held together by a polypropylene copolymer 4. The pipe-shaped core 2 is formed by bending over a sheet extruded, for example at 200°C, from an intimate mixture of sand particles and polypropylene and welding it tight along its edges with the formation of a weld seam 9 running in the longitudinal direction.

The core layer contains approximately 80% sand particles and 20 % by weight polypropylene copolymer.

An outer layer 10 of fibre-reinforced polypropylene plastic tape 5 with a glass fibre reinforcement 6 with continuous glass fibres extending in the longitudinal direction of the tape is wound around the core 2 in the tangential direction. The outer layer is therefore formed by tangential windings of the fibre-reinforced plastic tape 5, the windings 7 being mutually tightly joined by welding the edges 8, 8a together.

In Fig. 2 a modified embodiment is shown which essentially corresponds to that in Fig. 1 but in which the core 2 of sand particles with polypropylene copolymer 4 is first surrounded by a plastic tape 5' with a glass fibre reinforcement extending in the axial direction of

the pipe. The tangentially wound layer 5 is then applied around this.

In this way the strength characteristics of the plastic pipe according to the invention, and its resistance to internal pressures and external loads, can be improved.

Another embodiment is shown in Fig. 3; in this embodiment there is also an inner layer 10' of glass fibre-reinforced polypropylene on the inside of the core 2 containing sand particles 3 and polypropylene copolymer 4. In this embodiment, the core layer 2 is applied by extrusion in pipe form around the wound inner layer 10'. The core layer 2 is, in its turn, again surrounded by an outermost winding layer 10 of glass fibre-reinforced polypropylene tape 5. In this embodiment also, an axial reinforcement from inside and/or outside is also possible, as a result of which axial forces also can be better absorbed, as can be necessary in pressure lines with welded joins, inter alia where the line changes direction.

The customary sand particles have a size of 0.2 to 2 mm. The pipe diameters can vary from about 100 mm to 1000 mm; the core layer then has a thickness of 2-25 mm and the outer layer a thickness of 0.3-3 mm.

It will be clear that the thermoplastic used in the core 2 and the inner layer and outer layer 10', 10 can be different.

Instead of an extruded sheet of an intimate mixture of sand particles 3 and polypropylene copolymer 4, it is also possible to use a cast sheet as starting material, the casting then taking place at about 200°C, i.e. a temperature at which the thermoplastic is molten.

Bending over the sheet to form the core 2 expediently takes place at a temperature at which the thermoplastic has softened, for example 160°C for a polypropylene copolymer.

Fig. 4 shows yet another embodiment of the core 2, which is produced by winding a thin web 11 of sand particles 3 and polypropylene copolymer 4. This thin web

is formed by extruding or casting or another known technique, at a temperature of 200°C.

After cooling to 160°C, the flexible layer is wound on a mandrel 12 until a layered core 2 of the desired thickness is obtained, after which polypropylene tape 5 is wound round this, forming the outermost winding layer 10. The tape 5 may also consist of a polypropylene copolymer.

If the thin web 11 is sufficiently self-supporting, the core 2 can also be wound without the use of a mandrel 12.

The layers of the thin web 11 can also adhere easily to one another at a suitable temperature during winding, in which case a non-layered core 2 is formed as shown in Fig. 5.

Table A

Material	External diameter (mm)	Pressure category (bar)	STIS (N/m^2)	Wall thickness (mm)			Modulus of elasticity kN/mm^2		
				layer 1	layer 2	layer 3	layer 1	layer 2	layer3
PVC	315	6.3	4000	7.7	-	-	3.0	-	-
PP	315	6.0	18000	17.9	-	-	1.0	-	-
PP	315	3.5	4000	11.0	-	-	1.0	-	-
FRPP	315	6	50	0.9	-	-	25.0	-	-
TPC	315	-	4000	-	9.4	-	-	1.7	-
TPC + FRPP	315	6	4000	-	6.0	0.9	-	1.7	25.0
FRPP + TPC + FRPP	315	6	4000	0.3	4.2	0.6	25.0	1.7	25.0

The pressure category is calculated in accordance with ISO 161/I (1978)

The STIS is calculated in accordance with the equation $STIS = E/12 \cdot e^3/(D-e^3)$

Wherein:
E = modulus of elasticity
e = wall thickness
D = external diameter

CLAIMS

1. Plastic pipe (1) comprising a wall of a plastic-filler layer (2) having a high filler (3) content and being covered at least on one side by a fibre-reinforced plastic layer (10), characterized in that the plastic of the filler layer (2) and of the fibre-reinforced layer (10) consists of a thermoplastic.

2. Plastic pipe according to Claim 1, characterized in that the plastic of the filler layer and of the fibre-reinforced plastic layer consists of a polyolefin.

3. Plastic pipe according to Claim 2, characterized in that the plastic of the filler layer and of the fibre-reinforced plastic layer consists of a polypropylene, preferably a polypropylene copolymer.

4. Plastic pipe according to one or more of the preceding claims, characterized in that the fibre-reinforced plastic layer is formed by winding a fibre-reinforced plastic tape (7), preferably said fibre-reinforcement extending in the longitudinal direction of the plastic tape.

5. Plastic pipe according to Claim 4, characterized in that the fibre reinforcement is continuous, preferably in the form of a continuous glass fibre.

6. Plastic pipe according to one or more of the preceding claims, characterized in that the plastic tape is wound essentially tangentially.

7. Plastic pipe according to one or more of the preceding claims, characterized in that the plastic-filler layer (2) consists to at least 60 to 95 % by weight of filler, preferably inorganic filler.

8. Plastic pipe according to Claim 7, characterized in that at least 75-90% of the plastic-filler layer (2) consists of an inorganic filler.

9. Plastic pipe according to one or more of the preceding claims, characterized in that at least one reinforcing tape (5') extending axially is incorporated in the wall, preferably said axial reinforcement consisting of a plastic tape with reinforcing fibres

extending in the axial direction of the pipe.

10. Plastic pipe according to one or more of the preceding claims, characterized in that the plastic--filler layer (2) of the pipe is formed to a pipe by shaping a sheet or thin web (11) of plastic containing filler and welding together the edge sections of the shaped sheet or web with the formation of a weld joint (9), preferably said sheet or thin web (11) being formed by casting or extruding.

11. Plastic pipe according to one or more of the preceding claims, characterized in that a plastic-filler layer (2) of the pipe is formed by winding a thin web (11) of plastic containing filler and preferably the layers of sheet or web (11) formed during winding are joined together by melting the plastic.

12. Plastic pipe according to Claims 10 or 11, characterized in that the shaping of the sheet or web (11) takes place at a temperature within the softening range of the plastic used.

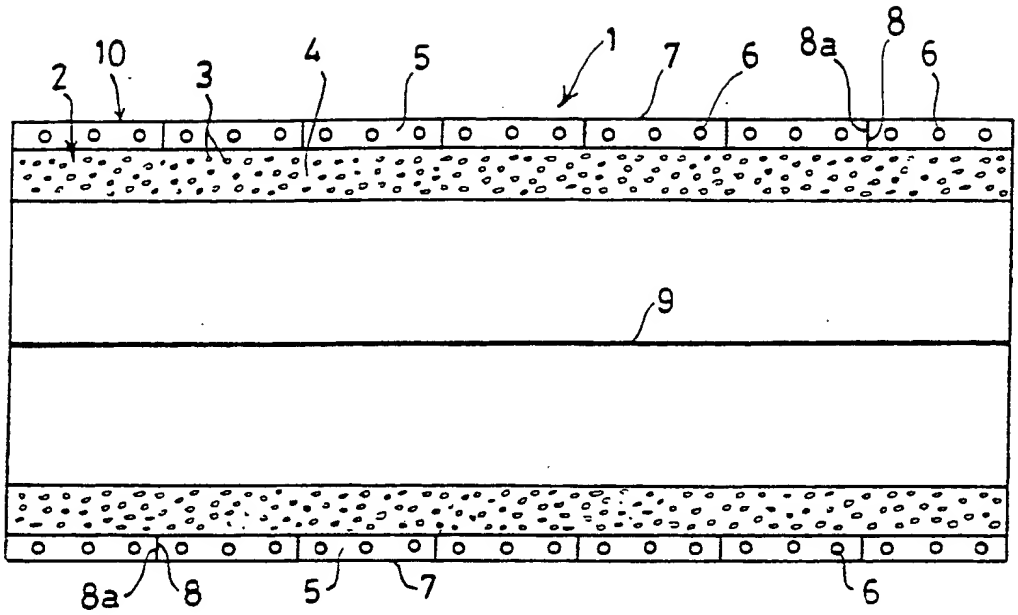

Fig. 1.

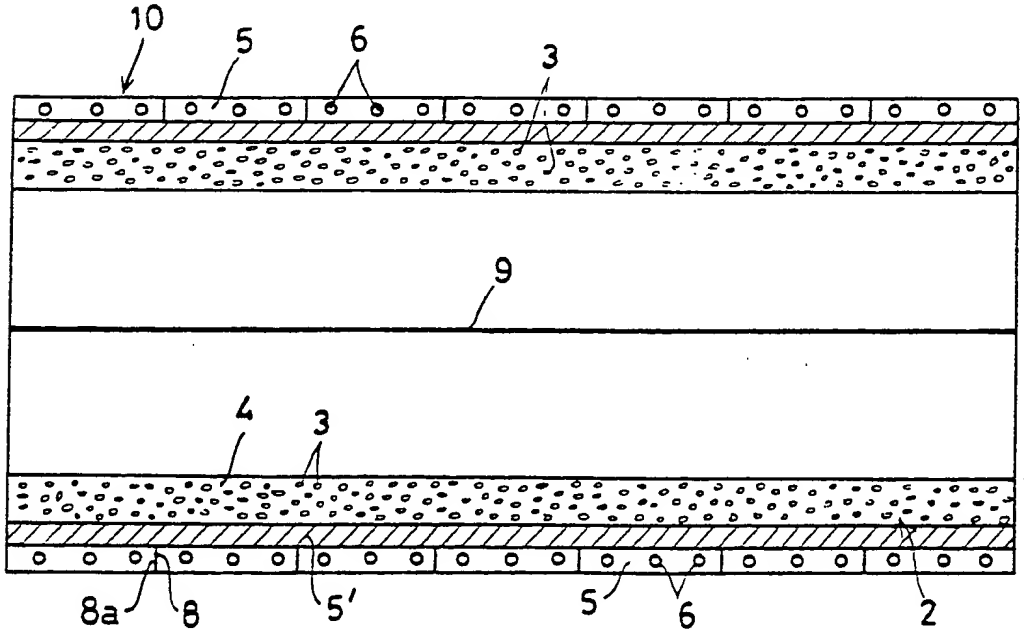

Fig. 2.

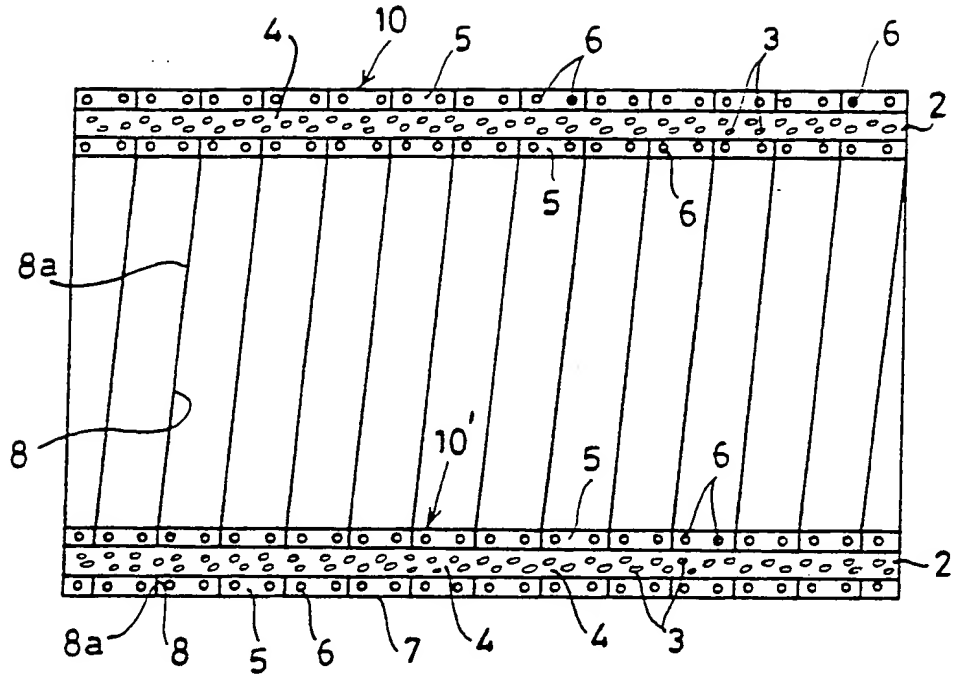

Fig. 3.

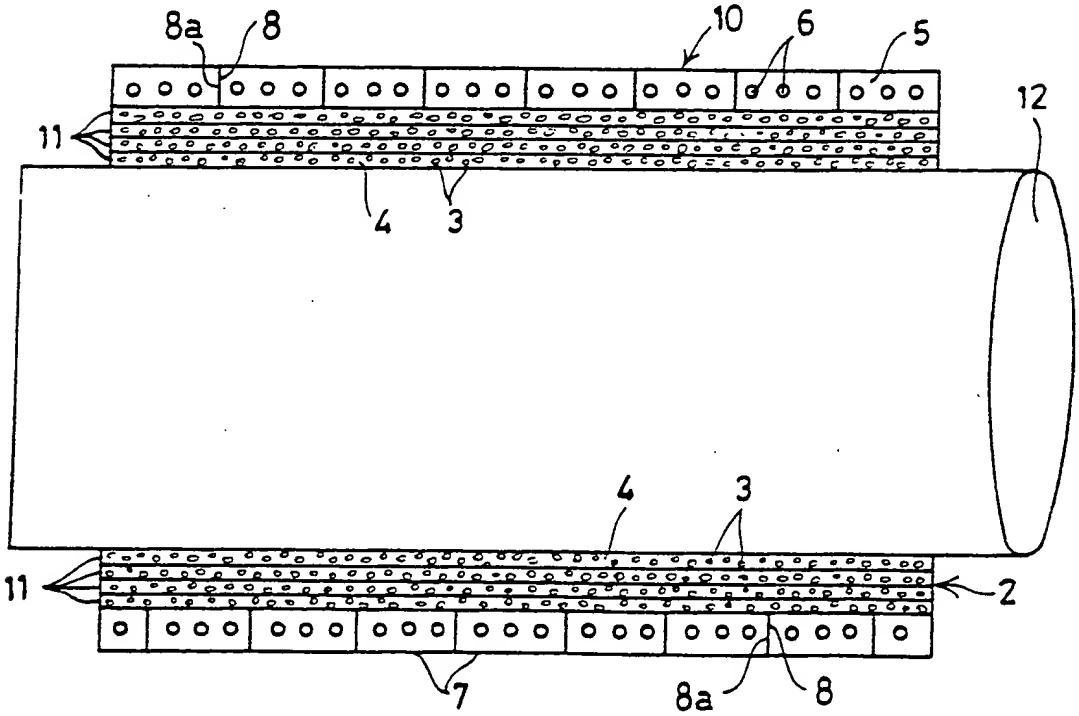

Fig. 4.

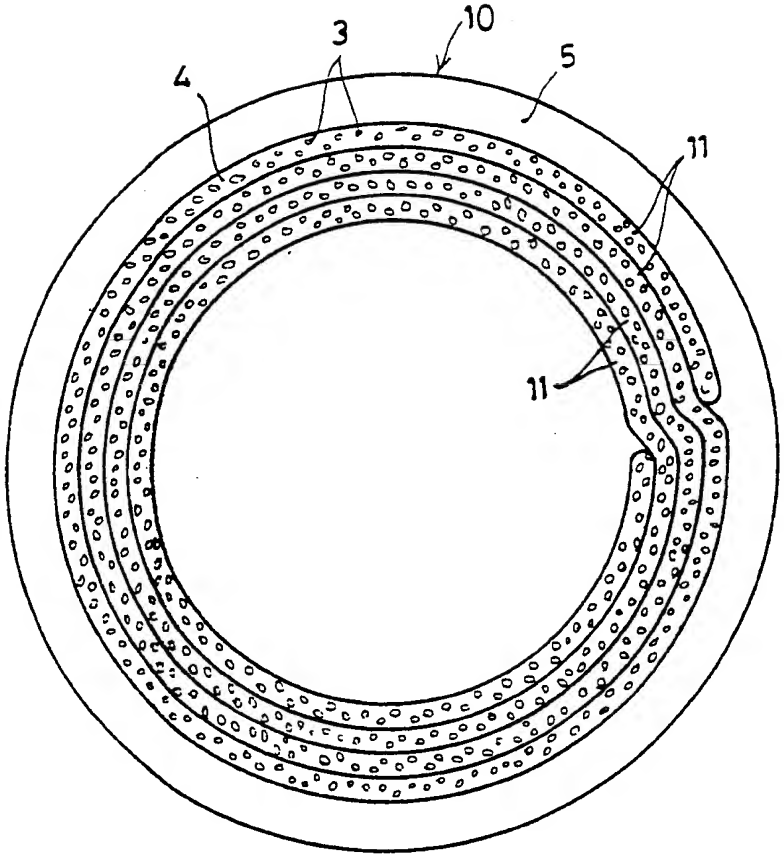

Fig: 5.

INTERNATIONAL SEARCH REPORT

International Application No PCT/NL 90/00176

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [6]

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC[5]: B 29 C 67/12, B 29 C 67/24, F 16 L 9/133,// B 29 K 23:00, B 29 L 23:22

II. FIELDS SEARCHED

Minimum Documentation Searched [7]

Classification System	Classification Symbols
IPC[5]	B 29 C, F 16 L

Documentation Searched other than Minimum Documentation to the Extent that such Documents are included in the Fields Searched [8]

III. DOCUMENTS CONSIDERED TO BE RELEVANT [9]

Category [10]	Citation of Document, [11] with indication, where appropriate, of the relevant passages [12]	Relevant to Claim No. [13]
X	EP, A, 0291639 (PHILLIPS PETROLEUM) 23 November 1988 see the whole document --	1-6,9,11,12
X	FR, A, 2114550 (MANNESMANN) 30 June 1972 see the whole document --	1,2
X	EP, A, 0297801 (CHEN SHIJIE) 4 January 1989 see the whole document --	1,2,7
A	Patent Abstracts of Japan, vol. 6, no. 161 (M-151)(1039), 24 August 1982, & JP, A, 5775837 (AISHIN KAKOU K.K.) 12 May 1982 see the abstract --	1,2

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IV. CERTIFICATION

Date of the Actual Completion of the International Search	Date of Mailing of this International Search Report
14th March 1991	19. 04. 91
International Searching Authority	**Signature of Authorized Officer**
EUROPEAN PATENT OFFICE	F.W. HECK

III. DOCUMENTS CONSIDERED TO BE RELEVANT (CONTINUED FROM THE SECOND SHEET)		
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A	US, A, 3714312 (HARUO NITTA) 30 January 1973 see the whole document --	1,2
A	EP, A, 0011436 (LOCKHEED) 28 May 1980 see the whole document --	1,4-6,9,11, 12
A	US, A, 4044188 (L. SEGAL) 23 August 1977 see the whole document --	1-3,7,8
A	WO, A, 8505593 (DOW CHEMICAL) 19 December 1985 see the whole document --	1-3,7,8
A	FR, A, 1452533 (HÖGANÄSMETODER) 9 September 1966 see the whole document --	1,7,8
A	FR, A, 1497527 (SAINT-GOBAIN) 13 October 1967 see claims; figures ----------	1,10

ANNEX TO THE INTERNATIONAL SEARCH REPORT ON INTERNATIONAL PATENT APPLICATION NO. NL 9000176 SA 42566

This annex lists the patent family members relating to the patent documents cited in the above-mentioned international search report. The members are as contained in the European Patent Office EDP file on 03/04/91
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